Front Feature Selection Approach for Face Recognition

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Abstract— **In recent years, the biometrics field has gained a great attention on a world level. One of the most important parts of biometrical measurements is face recognition. The Viola Jones algorithm was used to detect Eyes, Nose, mouth and full face for frontal face recognition system in the offline. For the features extraction step, the Histogram Oriented Gradients algorithm (HOG) is utilized. Because this method had a high degree of robustness to the changes in image illumination. The detected faces have been recognized by using Principal Component Analysis algorithm (PCA). Finally, the Euclidean distance algorithm does the comparison step for the feature vectors.**

Index Terms— **Face Recognition, Euclidean Distance, Viola and jones's, HOG, PCA.**

I. INTRODUCTION

Human face recognition is a very challenging research area, and it is gaining much attention during the last years. Face recognition used in law enforcement and commercial crowd surveillance applications, such as surveillance systems, smart homes, or any application that deals with identifying people from images or videos [1] [2]. The art of recognizing human face is completely difficult as it exhibits characteristics like the variations in expressions, pose or even occlusion [3]. All of these variation affected Feature extraction step in face recognition operation [4]. Feature representation has to be performed well to maximize the difference between persons [4].

The proposed methodology has been implemented in two stages, which are face detection and face recognition [5]. Different techniques have been used for face recognition. Among those, Neural Networks, Algebraic Moment, Elastic Template Matching, Local Binary Pattern, Principle component analysis [6] . For the fast detection step Viola and Jones algorithm was used, by using rectangular features that can be computed from the integral image [7]. Since the human face has been identified by the detection step, the relevant features are extracted from the facial image [8].

This paper is focused on comparing between two methods. The two use the same feature extraction algorithm (HOG) for the front view system for face recognition. But the first one method (A) takes the features value for (eyes, nose and mouth) and the other method (B) takes the features for all the face And then evaluate the results for each of them .The method (A) solves the existing processing speed problem in method (B) for the recognition, the detection and feature extraction in training stage. In addition, increases the accuracy rate. Section 1displayed the recent techniques. In section 2, we describe our methods working. Then in section3, the experimental results are displayed.

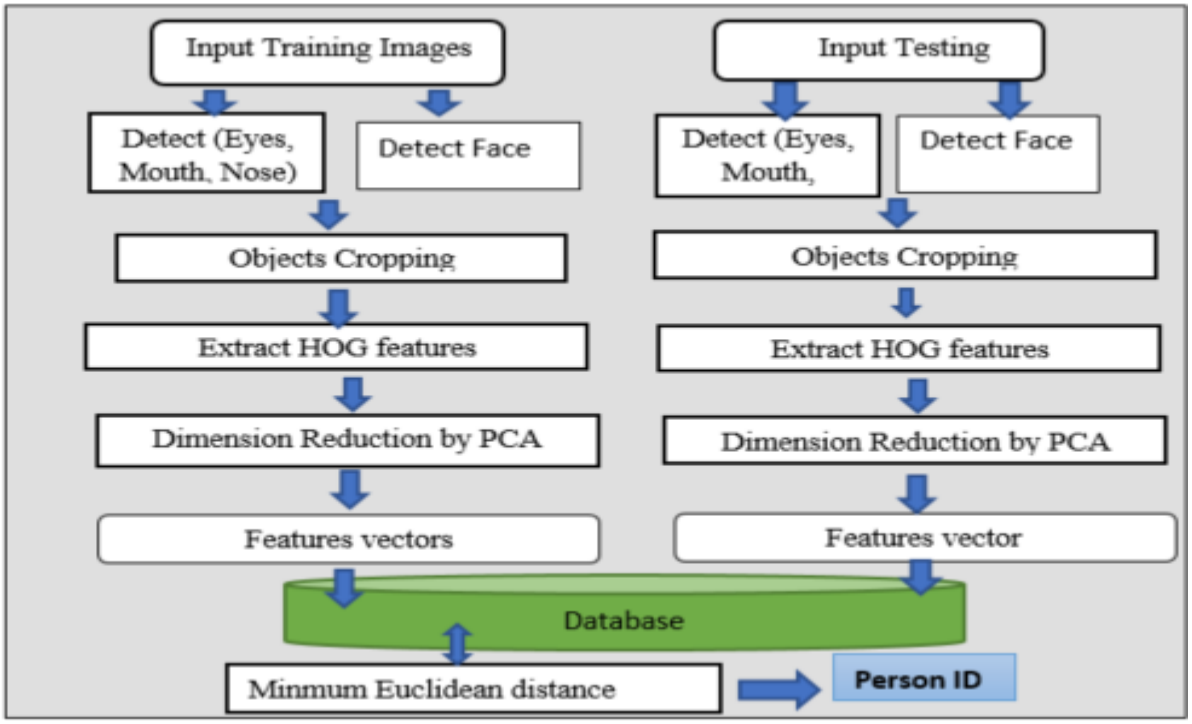
II. RELATED WORKS

In [1], the author proposed automatic face detection system by using Deformable Template algorithm. The Eigen faces approach utilized for face recognition and the recognition rates 73% achieved. In [2], proposed new approach by using of three appearance based stastical methods principle component analysis (PCA), Independent component analysis (ICA) and Linear Discriminant Analysis (LDA) algorithms for face recognition and the performance measurement evaluated between them. In [3], generated side view image from 2D face image by creating mirror image. For the detection phase, the Viola and Jones algorithm has been used and Local Binary Pattern for feature enhancement was utilized. In [5], the author proposed facial expressions recognizer system. For region of interest detection, the Viola and Jones algorithm was used. In addition, for feature extraction Histogram Oriented Gradients (HOG) was used. To make dimensionality reduction ICA, LDA or PCA were used. In [6], proposed implementing the system in two stages. Detection by Viola and Jones algorithm is the first stage. Moreover, for face recognition PCA with feed forward Neural Network was used in the second stage. The BIO ID Face-Database was used to test the system. In [7], for the face, recognition the author used Support Vector Machine (SVM) and Eigen faces algorithms for the front view image, and Support Vector Regression implemented the Pose estimator for face detection.

III. PROPOSED METHOD

The proposed method implementation used efficient techniques for face detection and recognition, which is independent of the variations in features like color, hairstyle and using of the glasses on the eyes. The proposed system consists of set of steps shown in Fig. 1.In method (A) the eye,

nose and mouth have been detected, in method (B) the entire face has been detected. For both methods, the same feature extraction and recognition steps were evaluated. The proposed method is implemented several steps as follows:



Fig, 1: The proposed system structure

A. Detect object

By Viola Jones algorithm. It is more effective on frontal images of faces, and can cope with 45◦ face rotation for both around the vertical and horizontal axes. As it is known, there are some similarities in human faces. The concept to detect eye, nose and mouth in the images has been used in method (A) and it takes the front view in zero angle. In addition, detecting the entire face region in the method (B). If these features are found in the image the algorithm passes the candidate to the next stage. Which is not whole the image but sub-window that has a specific size. Viola Jones algorithm works in four stages Haar features, creating an integral image Adaboost learning and cascade classifier. The detection for each object is shown in Fig. 2 and Fig.3.

B. Objects Cropping

The detected object is cropped and resized to 32×64 pixels in method (A).And for method (B) the detected face is cropped and resized by 64×64 pixels. The Haar features are calculated and all the related features will be extracted in the next step.

C. Extract HOG features

Extracting HOG features from each cropped and resized object. Where main features of the face are identified by Voila-Jones algorithm marked by a bounding box from the previous step .The HOG algorithm is very simple to understandable because it is used to extract ”global” features rather than “local” ones and it represented the entire person by a single feature vector. The HOG extracts 756 features form each object for method (A), Depending on the object dimensions. The summation of all will be 2268. And for method (B) the number of features will be 1764. Then it collects all features from the frontal view of the image for each program separately to store them in the feature database.

D. Dimension Reduction PCA

Feature reduction and classification step is done by PCA .Which is a mathematical procedure. It reduces the features value dimensionality that contain many variables correlated with each other to uncorrelated variables called the Eigen faces. The PCA retains the maximum variation present in the original components. To reduce the steps of calculations the dimension of the original images have to be reduced before calculating the principal components. Since principal components show less direction and more noise, the first few principal components (say F) will be selected and the remaining components ignored because they contain more noise. A training set of N images are represented by the best Eigen faces with largest Eigen values and counts for the most variance within the set of face images and best approximate the face. After determining Eigen faces each image in the training set will be represented by a linear combination of Eigen faces and can represented as vectors. The input image features will be compared with all the features in the database for recognition result. Moreover, the decision will be made by Euclidean Distance. This is useful in several applications where the input data consists of an incomplete set of

distances and the output is a set of points in Euclidean space realizing those given distances.

IV. TRAINING STAGE

To evaluate the performance of face detection and recognition the FEI face database is used [9]. It is a face database in Brazil, which includes a group of face images. Which have tacked from June 2005 to March 2006, at the Artificial Intelligence Laboratory of FEI located in São Bernardo do Campo, São Paulo, Brazil. In this dataset, there are (10 images) that belong to each one of (50 persons), with 500 images as a total to detect human face. Four views images are used for the training in methods (A) and (B) and one image is used for testing for every 12 persons. For the training stage 48-face images as total. For the testing stage 12_face images are used for each method.

V. TESTING STAGE

In this step, the input image will be compared with all images stored in the database as in Fig.2. And Fig3. Show the steps of image testing in methods (A) and (B).
At first, the system will get the input image then the face objects in method (A) and the whole face for method (B) will be detected by using viola and jones algorithm. The next step is cropping each object in method (A) and resizing the Eyes by 32*64 pixels. The mouth by 64*32 pixels and the nose by 32*64 pixels. In addition, in method (B) face dimension will be 64×64. Then extract the HOG features for each detected object. The reduction in size made by PCA that produces the covariance matrix and puts the features in one vector. The last step is comparing between extracting vector from tested images and all the vectors that are stored in the database. By using the Euclidean distance algorithm, the minimum distance will be produced. In addition, this leads to returning the persons ID. As shown in Fig. 4 and Fig. 5.

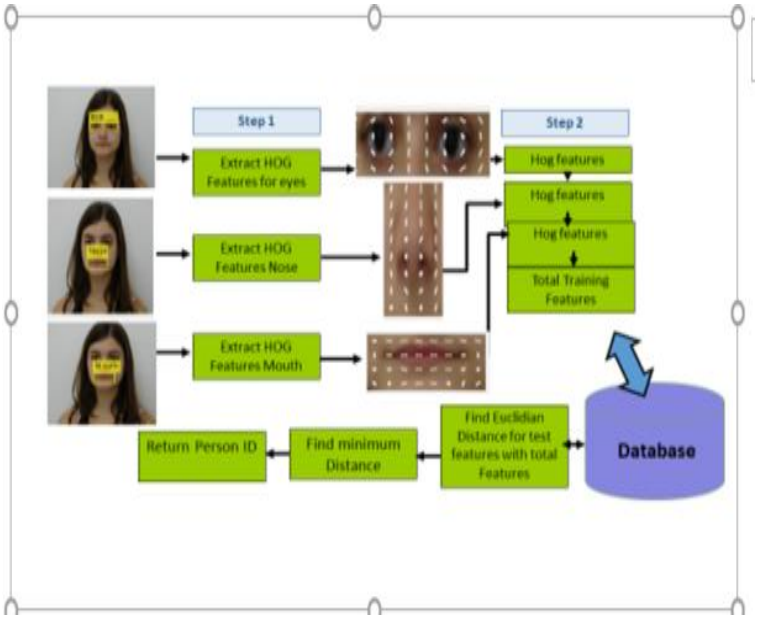


Fig. 2: Image testing for the system A

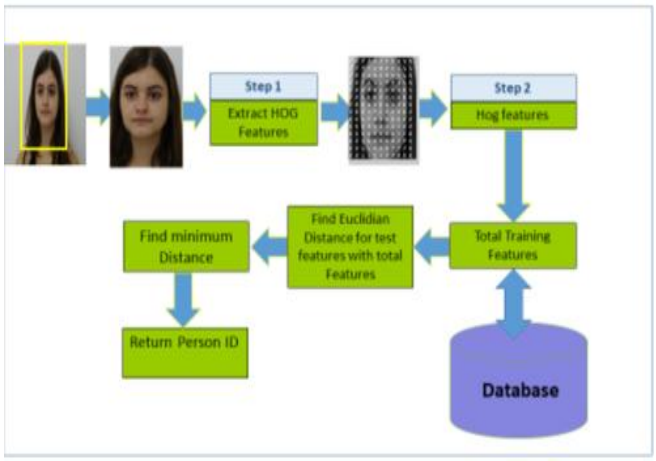


Fig. 3: Image testing for the system B

VI. EXPERIMENTAL RESULTS

The proposed system has been implemented using MATLAB 2017 environment. The tests have been conducted on an HP PC with core i7 processor. The first step is detect eyes, crop and resize to 32×64 pixels from detection step. Extracting HOG features for eyes 1×756 of features, for the mouth 1×756 features and for the Nose 1×756 features. Then finding the summation of features [1×756]+[1×75]+[1×756]=[1×2268] for method(A) . Moreover, 1764 features for method (B) depending on the detected image size 64×64. In the HOG algorithm, the number of features depended on the size of the image (32×64). The image will be split to blocks as follows:

Number of features=block height ×block width×9×4

In addition, Number of features=3×7×9×4=756, where nine represents the number of bins in histogram for each object and four represents the number of cells. Each detail for their feature values tabulated in MATLAB program. Now, the reduction step of the features size is done by using the PCA algorithm to increase the system processing speed. Each person has five views 12×4 = 48 the number of training images, the covariance matrix for PCA will reduce the size of features for training images to [48×48] instead of [48×2268] depending on the HOG features for method (A).For method (B) will be [48×48] instead of [48×1764]. By using Euclidean distance algorithm, the minimum distance is computed. Then returning the person's ID for the recognized person. Fig. 4 shows the tested image as the first step in MATLAB program for method (A). Then, extracting face features and displaying all the views that are stored in the label database. The minimum Euclidean distance depends on the HOG features for comparing the test image and all image features in the database. The returning in MATLAB program the person ID number is shown in Fig.5.

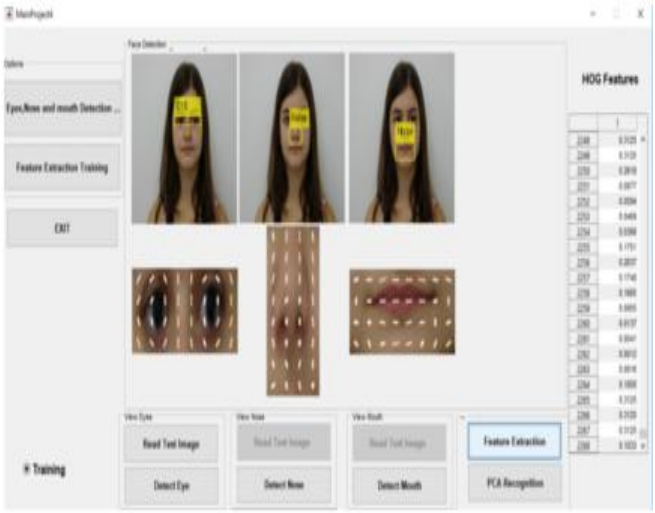
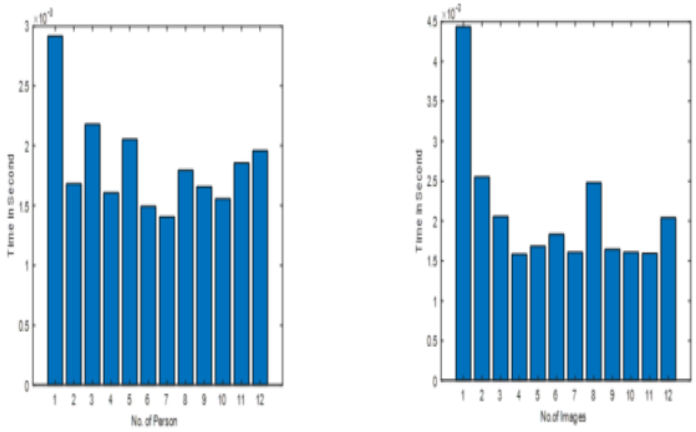


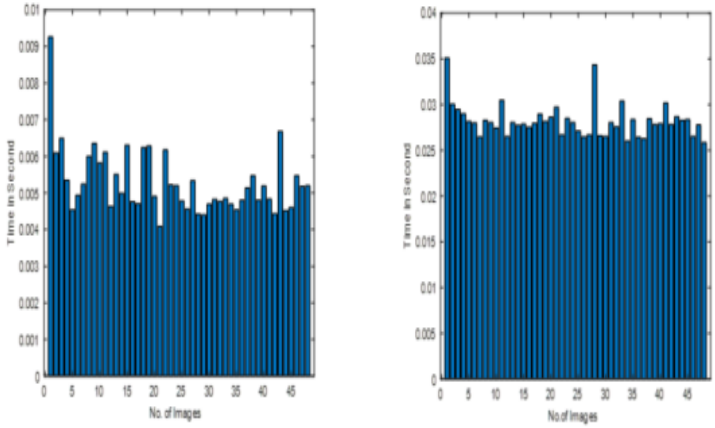
Fig. 4: Test the front view image



a. Method A b. Method B

Fig. 6: Shows the time of recognition in (method A) and for (method B) for the test images.

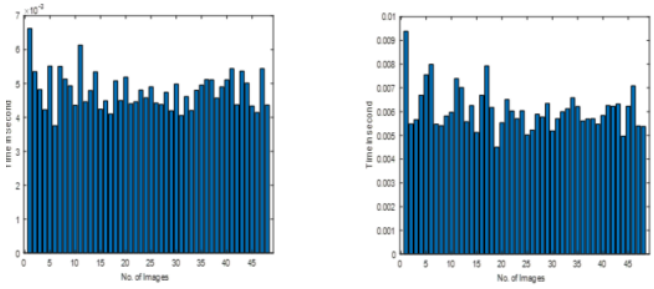
Fig. 5: ID of Founded Person and all its multi views that stored in the Database.



a. Method A b. Method B

Fig. 7: detection shown for (method A) and the face (method B) for training images.

The processing time reduced by optimizing the number of the features. The test image execution time for the eye, mouth and nose (method A) recognition and the all face region (method B) shown in the Fig. 6. In addition the detection time in seconds for (eyes, nose and mouth) d for (method A) and the face (method B) (training images) shown in Fig. 7 .Finally, the features extraction time in seconds for eyes, nose and mouth for (method A) and the face (method B) (training images) shown in Fig. 8.



a. method A b. Method B

Fig. 8: Execution time in (method A) and (method B) for the features extraction (Training Images)

From previous results it is noted that the change in the time ranges depends on the pixel values of the image in the training and testing images. Tables 1 and Table 2 show the effect of changing image size on the number of the features which leads to changing the accuracy rate in method (A) and method (B).

Table 1: Method A

Eyes size	Nose size	Mouth size	Number of features	Accuracy
16×32	32×16	16×32	108×3=324	73%
32×64	64×32	32×64	756×3=2268	92%
48×96	96×48	48×96	1980×3=5940	95%

Table 2: Method (B)

Image size	Number of features	Accuracy
32×32	324	68%
64×64	1764	91%
96×96	4356	93%

VII. CONCLUSION

The purpose of this project is to implement the Viola and Jones face detection algorithm and to obtain reasonable performance. The results of our tests met our expectations. In terms of the processing time of our final detector, or for the feature extraction time. Surprisingly, the time bottleneck was not at the AdaBoost learning phase but the Haar-like rectangular feature extraction phase. The methods were evaluate in MATLAB environment in the offline using an image from FEI database of 48-face images containing four views for 12 persons for the frontal views in (method A) and (method B). After training images, the highest accuracy rate that has been obtained reached 95.66% for method (A) when the image size 48×96 for eyes and mouth and 96×48 for the nose. Moreover, 93% for method (B) for the image size 96×96 for 12 consecutive trials. Method (A) has the advantage in terms of using smaller database size and higher speed in processing time and it achieved higher accuracy rate. It is useful in applications that need higher processing speed. The use of Euclidean distance was very efficient and increased the speed of matching with the database

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